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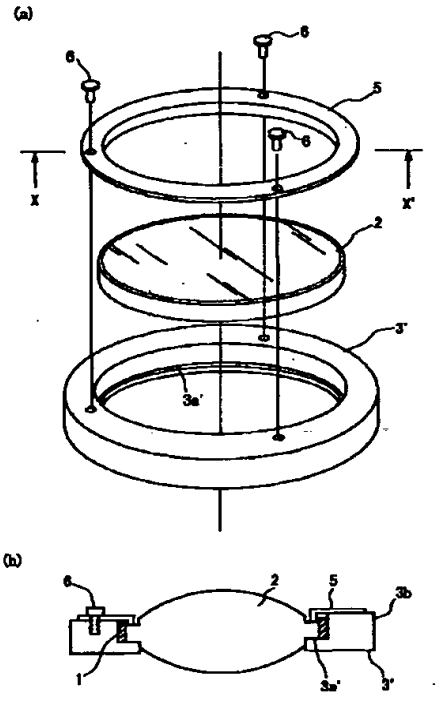
(54)【発明の名称】　光学構造体、その光学構造体を組み込んだ投影露光用光学系及び投影露光装置

(57)【要約】
【課題】 放射ビーム（例えば、波長３５０ｎｍ以下の光ビーム）の照射による光学部材の光学特性（例えば、透過率又は反射率）の変動を防止できる光学構造体及び光学系、並びに投影露光装置を提供する。
【解決手段】　少なくとも一つの光学部材を、接着材又は充填材により支持部材に固定してなる光学構造体において、前記接着材又は充填材の表面に、保護部材を設けたことを特徴とする光学構造体。



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【特許請求の範囲】

【請求項1】少なくとも一つの光学部材を、接着材又は充填材により支持部材に固定してなる光学構造体において、

前記接着材又は充填材の表面に、保護部材を設けたことを特徴とする光学構造体。

【請求項2】光ビームが照射される光学部材を、接着材又は充填材により支持部材に固定してなる光学構造体において、

前記光ビームの前記接着材又は充填材への照射、或いは該照射による前記接着材又は充填材からのガスの発生を防止する遮蔽部材を備えたことを特徴とする光学構造体。

【請求項3】前記保護部材又は前記遮蔽部材が薄膜であることを特徴とする請求項1又は2記載の光学構造体。

【請求項4】前記薄膜が、Ni,Si,Au,Pt,W,Mo,Cr,Ti,Al及びこれらの合金又は化合物の群より選択された1つ以上の成分を含んだ金属膜であることを特徴とする請求項3記載の光学構造体。

【請求項5】前記保護部材又は前記遮蔽部材は、前記接着材又は充填材を覆って略密封された空間を形成するカバーと、該密封空間にガスを導入するガス導入管と、その密封空間からガスを排出するガス排出管と、を有することを特徴とする請求項1又は2記載の光学構造体。

【請求項6】前記密封空間に導入される前記ガスがN_2、Ar、He、H_2のいずれか選択されたガス、又はこれらのガスから選択された2種類以上のガスを含む混合ガスであることを特徴とする請求項5記載の光学構造体。

【請求項7】請求項1～6のいずれかに記載の光学構造体が組み込まれた投影露光装置用光学系。

【請求項8】マスクを照明する照明光学系と、

前記マスクに形成されたパターンを基板上に投影露光するための投影光学系と、を具備する投影露光装置において、

前記照明光学系又は前記投影光学系に請求項7記載の投影露光装置用光学系を用いたことを特徴とする投影露光装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、紫外線の照射及び光洗浄に適した光学構造体及びそれを組み込んだ投影露光装置用光学系に関する。

【0002】

【従来技術】近年、半導体素子の集積度を増すために、半導体製造用縮小投影露光装置（以下、投影露光装置という）の高解像力化の要求が高まっている。この投影露光装置によるフォトリソグラフィーの解像度を上げる一つの方法として、光源波長の短波長化が挙げられる。そこで、紫外線領域（$\lambda \leqq 350nm$）に発振スペクトルを有

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するエキシマレーザーを光源とした露光装置が用いられはじめている。

【0003】投影露光装置等の光学系を構成する光学部材2（レンズ、ミラー等）は、図8に示すように、円環状の支持部材3の固定部（段部）3aに固定されて使用されるが、光学部材2の外周面を支持部材3内の固定部3aに固定するためには、一般的には、接着材又は充填材1が使用されている（以下、これら（1～3、3a）をまとめて「光学構造体」という）。特に、投影露光装置のような精密機器に使用される光学構造体の場合、固定部3aに保持される光学部材2が変形しないように、シリコン系の接着材又は充填材1が使用されている。

【0004】

【発明が解決しようとする課題】ところで、投影露光装置内及びその光学系内では、幾何学上、波動光学上で光が通る部分（光学部材で形成される光路）以外の場所にも散乱現象によって紫外線が照射される。また、光学部材を投影露光装置に組み込んで、紫外線を照射した場合に、光学部材本来の特性から算出される透過率（又は反射率）を達成することができない、或いは、透過率（又は反射率）の変動がある。即ち、光学部材が投影露光装置に組み込まれる過程で光学部材の有機物等による汚染が原因となって上記問題が生じている。

【0005】そのため、最近、光学部材の製造工程での光洗浄は勿論のこと、光学部材の支持部材への組み込み工程、その支持部材（光学部材が組み込まれた支持部材）の鏡筒への組み込み工程、及びその鏡筒（光学系）の投影露光装置への組み込み工程での光洗浄、即ち、支持部材に組み込まれた状態における光学部材、鏡筒に組み込まれた状態における光学部材、及び投影露光装置内に組み込まれた状態における光学部材の光洗浄の必要性が叫ばれるようになってきた。

【0006】その光洗浄のうち最も有効なものは、低圧水銀ランプから放射される185nmと254nmの光を用いた光洗浄である。光洗浄のメカニズムを簡単に説明すると、酸素（O_2）は185nmの光を吸収し、活性酸素になり、その活性酸素の一部が酸素と反応してオゾン（O_3）になる。　また、オゾンは254nmの光を吸収し、活性酸素と酸素を発生する。

【0007】この様にして発生したオゾンと活性酸素により、被洗浄物上の有機物は酸化され、洗浄される。しかしながら、光学部材を支持部材の固定部に固定するシリコン系の接着材や充填材は、紫外線が照射されたり、光洗浄の際に発生するオゾン、活性酸素等のガスに曝されると変質が起こり、接着力の低下、弾性力の変化が起こる。

【0008】また、この接着材や充填材の変質は、光学部材の支持状態を変化させたり、光学部材に不要な応力を与えて変形させる原因となる。さらに、シリコン系の接着材や充填材は、紫外線が照射されたり、光洗浄の際

に発生するオゾン、活性酸素等のガスに曝されると、アウトガスが発生する。この発生したアウトガス（分子）によって光学部材上に付着する付着物（有機物等）は、光源から照射される紫外線の吸収の原因となる。

【０００９】この付着物（有機物等）は、アウトガス（分子）が光学部材上に付着して形成される場合と、アウトガスが気体中で反応して、その反応物が光学部材上に形成される場合とが考えられる。特に、紫外線を露光光とする投影露光装置に使用する場合には、エキシマレーザーが照射されたシリコン系の接着材や充填材からのアウトガスが光学部材の表面に付着することにより、光学部材の耐久性の低下を引き起こす。

【００１０】このように、シリコン系の接着材や充填材は、耐紫外線性、耐酸化・腐食ガス性に問題はあるものの、光学部材を金属、セラミックスの支持部材に固定する材料として、それ以上に優れた特性を有するものが存在しないのが現状である。そこで、本発明は、放射ビーム（例えば、波長３５０ｎｍ以下の光ビーム）の照射による光学部材の光学特性（例えば、透過率又は反射率）の変動を防止できる光学構造体及び光学系、並びに投影露光装置を提供することを目的としている。　さらに、接着材又は充填材により支持部材又は鏡筒に固定された光学部材、複数の光学要素からなる光学系に組み込まれた光学部材、及び投影露光装置に組み込まれた光学系の光学部材を光洗浄できる光学構造体及び光学系、並びに投影露光装置を提供することも目的とする。

【００１１】

【課題を解決するための手段】本発明は、第一に、「少なくとも一つの光学部材２を、接着材又は充填材１により支持部材３、３’に固定してなる光学構造体において、前記接着材又は充填材１の表面に、保護部材４、５、７を設けたことを特徴とする光学構造体（請求項１）」を提供する。

【００１２】請求項１記載の光学構造体は、接着材又は充填材の表面に保護部材を設けたので、紫外波長域の光ビームがその接着材又は充填材に照射されることがない。従って、接着材又は充填材からのアウトガスの発生を防止でき、有機物等の異物が光学部材の表面に付着することがない。これにより、光ビームの照射に伴う光学部材の光学特性（透過率、反射率等）の変動を防止できる。また、光学部材を接着材又は充填材により支持部材上に固定したまま、例えば１８５ｎｍと２５４ｎｍの光ビームを光学部材に照射してその表面に付着した物質（例えば水、ハイドロカーボン、又はこれら以外の光ビームを拡散する物質）を除去する、光洗浄を行うことが可能となる。

【００１３】また、本発明は、第二に「光ビームが照射される光学部材２を、接着材又は充填材１により支持部材３、３’に固定してなる光学構造体において、前記光ビームの前記接着材又は充填材１への照射、或いは該照射による前記接着材又は充填材１からのガスの発生を防止する遮蔽部材４、５、７を備えたことを特徴とする光学構造体（請求項２）」を提供する。

【００１４】請求項２記載の光学構造体は、光ビームの接着材又は充填材への照射、或いは該照射による接着材又は充填材からのアウトガスの発生を防止する遮蔽部材を設けたので、接着材又は充填材に起因して生じる有機物などの異物が光学部材の表面に付着することがなく、光ビームの照射に伴う光学部材の光学特性（透過率、反射率など）の変動を防止できる。また光学部材を接着材又は充填材により支持部材上に固定したままで光洗浄を行うことも可能となる。

【００１５】また、本発明は、第三に「前記保護部材又は前記遮蔽部材が薄膜４であることを特徴とする請求項１又は２記載の光学構造体（請求項３）」を提供する。請求項３記載の光学構造体は、保護部材又は遮蔽部材を薄膜４にしたので、接着材又は充填材上に薄膜を成膜するだけの簡単な構造で請求項１又は２記載の作用を奏することができる。

【００１６】また、本発明は、第四に「前記薄膜４が、Ni,Si,Au,Pt,W,Mo,Cr,Ti,Al及びこれらの合金又は化合物の群より選択された１つ以上の成分を含んだ金属膜であることを特徴とする請求項３記載の光学構造体（請求項４）」を提供する。請求項４記載の光学構造体は、薄膜を金属膜にしたので、略完全に光ビームの接着材又は充填材への照射、或いは該照射による接着材又は充填材からのアウトガスの発生を防止することができ、請求項１又は２記載の作用を奏する。

【００１７】また、本発明は、第五に「前記保護部材又は前記遮蔽部材は、前記接着材又は充填材１を覆って略密封された空間を形成するカバー７と、該密封空間７ａにガスを導入するガス導入管７’と、その密封空間７ａからガスを排出するガス排出管７”と、を有することを特徴とする請求項１又は２記載の光学構造体（請求項５）」を提供する。

【００１８】請求項５記載の光学構造体は、光ビームの接着材又は充填材への照射、或いは該照射による接着材又は充填材からのアウトガスの発生を防止する保護部材又は遮蔽部材が、接着材又は充填材を覆って略密封された空間を形成するカバーと、該密封空間にガスを導入するガス導入管と、その密封空間からガスを排出するガス排出管とを有するので、ガス導入管から密封空間にガスを導入し、ガス排出管からガスを排出することにより、洗浄の際に発生するオゾンと活性酸素が、密封空間内に入ってくることを防止することができる。

【００１９】また、本発明は、第六に「前記密封空間７ａに導入される前記ガスがN_2、Ａｒ、Ｈｅ、H_2のいずれか選択されたガス、又はこれらのガスから選択された２種類以上のガスを含む混合ガスであることを特徴とする請求項５記載の光学構造体（請求項６）」を提供す

る。請求項6記載の光学構造体は、密封空間にガスがN_2、Ar、He、H_2のいずれか選択されたガス、又はこれらのガスから選択された2種類以上のガスを含む混合ガスを導入したので、接着材又は充填材と反応することなく、洗浄の際に発生するオゾンと活性酸素が、密封空間内に入ってくることを防止することができる。

【0020】また、本発明は、第七に「請求項1～6のいずれかに記載の光学構造体が組み込まれた投影露光装置用光学系（請求項7）」を提供する。請求項1～6のいずれかに記載された光学構造体が、例えば半導体素子、薄膜磁気ヘッド、撮像素子（CCD）等のマイクロデバイスを製造するリソグラフィー工程で使用される投影露光装置に搭載される光学系に組み込まれるので、紫外波長域の露光光（例えば波長193nmのArFエキシマレーザー、又は波長248nmのKrFエキシマレーザー等）やアライメント光等がその接着材又は充填材に照射されることがなく、接着材又は充填材からのアウトガスの発生を防止できる。従って、接着材又は充填材に起因して生じる有機物などの異物が光学部材の表面に付着することがなく、光学部材の光学特性（透過率、反射率等）の変動を防止できる。また、光学部材を光学系（鏡筒）に組み込んだ状態で光洗浄を行うことができ、その表面に付着した前述の物質を除去することが可能となる。

【0021】本発明の光学構造体が組み込まれる光学系は、例えばオプチカルインテグレータ（フライアイレンズ）やコンデンサーレンズなどの複数の光学要素を有し、露光光でマスクを照射する照明光学系、及び光軸に沿って配列される複数の光学要素（屈折素子、又は反射素子、或いは屈折素子と反射素子の両方）からなり、マスクに形成されたパターンの像を基板（半導体ウエハ等）上に投影する投影光学系等がある。さらに、例えばクリーンルームの床下に投影露光装置本体とは分離して配置される光源から射出される照明光をその本体内の照明光学系に導くとともに、照明光学系の光軸と照明光との位置関係を調整するための少なくとも1つの光学要素（可動ミラーなど）を有する送光系、マスク又は基板上のアライメントマークに紫外波長域の照明光を照射してその位置を検出するアライメント光学系、及び投影光学系の光学特性（例えば焦点位置、投影倍率、ザイデルの5収差など）を検出するために、マスク又は基板を載置するステージ上の基準マーク或いはマスク上の計測用マークに露光光又は露光光と略同一波長の照明光を照射し、該マークから発生して投影光学系を通る光を受光する計測用光学系などもある。

【0022】前述の送光系に本発明の光学構造体を組み込む場合には、送光系内の光学部材の透過率又は反射率の低下を防止でき、照明光学系に入射する照明光の減衰（強度低下）を抑えるとともに、露光動作に先立って光源から照明光を射出させる、即ち、光洗浄を行うことで、光学部材に付着した前述の異物を除去することが可能となる。

【0023】また、前述のアライメント光学系に本発明の光学構造体を組み込む場合には、光学部材の透過率又は反射率の変動による、アライメントマークに照射される照明光の強度変化を防止できる。さらに、アラトガス又はアウトガスが気体中で反応して生成される反応物による、アライメントマーク上での照明光の照度均一性の低下（照度むらの発生）を防止できるとともに、アライメント光学系の瞳面上のアライメントマーク上の1点に集まる照明光束が通過する領域内での光強度の均一性の低下による、照明光のテレセントリシティの崩れ（劣化）も防止できる。従って、アライメントマークの位置検出精度を低下させることがなく、マスクと基板とを高精度にアライメントすることが可能となる。

【0024】さらに、前述の計測光学系に本発明の光学構造体を組み込む場合にも、アライメント光学系と同様に光学部材の透過率又は反射率の変動による、マーク上での照明光の強度変化、及び照度均一性やテレセントリシティの低下を防止できる。従って、投影光学系の光学特性（例えば焦点位置、投影倍率、ザイデルの5収差など）を高精度に検出することが可能となる。

【0025】また、本発明は、第八に「マスクを照明する照明光学系21と、前記マスクRに形成されたパターンを基板W上に投影露光するための投影光学系25と、を具備する投影露光装置において、前記照明光学系21又は前記投影光学系25に請求項7記載の投影露光装置用光学系を用いたことを特徴とする投影露光装置（請求項8）」を提供する。

【0026】請求項7記載の光学系が投影露光装置の照明光学系又は投影光学系に組み込まれるので、露光光が接着材又は充填材に照射されることがなく、接着材又は充填材からのアウトガスの発生を防止できる。従って、接着材又は充填材に起因して生じる有機物などの異物が光学部材の表面に付着したり、照明光路や結像光路内に進入（浮遊）することがなく、照明光学系及び投影光学系の光学特性（透過率、反射率等）の変動を防止できる。また、照明光学系や投影光学系を投影露光装置に組み込んだ状態で光学部材の光洗浄を行うことができ、その表面に付着した前述の物質を除去することが可能となる。

【0027】さらに、照明光学系や投影光学系の透過率又は反射率の変動によるマスク又は基板上での照明光の強度変化を防止でき、常に適正な露光量でマスクのパターンを基板上に転写することが可能となる。さらに、アウトガス又はアウトガスが気体中で反応して生成される反応物による、マスク又は基板上での照明光の照度均一性の低下、及び投影光学系の光学特性（例えば、焦点位置、投影倍率、ザイデルの5収差、テレセントリシティ等）の変動を防止でき、常に良好な結像状態でパターン

像を基板上に投影し、かつ所期の特性を満足する半導体素子などのマイクロデバイスを製造することが可能となる。

【0028】また、照明光学系内に配置される光学素子により露光光の一部を分岐して光電検出器で受光する場合、照明光学系内の光学素子と光電検出器との間に配置される光学部材、及び／又は光電検出器を支持部材に固定する接着材又は充填材に本発明の保護部材又は遮蔽部材を設けてもよい。この場合にも、露光光が接着材又は充填材に照射されることがなく、接着材又は充填材からのアウトガスの発生を防止できる。従って、接着材又は充填材に起因して生じる有機物等の異物が光学部材や光電検出器（受光面）に付着したり、光路中に進入（浮遊）することがなく、常に精度良く受光光量（強度）を検出することができる。

【0029】

【発明の実施形態】以下、本発明にかかる実施形態の光学構造体を図面を参照しながら説明する。図1は、本発明にかかる第1の実施形態の光学構造体の概略断面図である。第1の実施形態の光学構造体は、光学部材（レンズ、ミラー等の光学硝材）2を支持部材3の内壁に段部として形成された固定部3aに接着材又は充填材1により固定し、その接着材又は充填材1の露出表面に、金属膜4を形成した構成である。

【0030】金属膜4としては、化学的に安定で、緻密なNi,Si,Au,Pt,W,Mo,Cr,Ti,Alおよびこれらの合金又は化合物の群より選ばれた1つ以上の成分を含んだ金属膜を用いることが好ましい。これらの金属膜は、適当な厚みにすることによって紫外線に対して良好な遮光性を有し、同時にアウトガスの飛散をシールする。また、成膜は真空蒸着法、スパッタ法等で行うことができるが、光学部材2の変形が発生しないように無加熱又は光学系の使用温度で成膜し、さらに接着材1の変質をさけるためにプラズマに曝されない成膜法を採用するのが好ましい。

【0031】尚、接着材や充填材1が光学部材2の周縁端面に沿った全周に渡って形成される場合、その全面に金属膜が形成される。第1の実施形態をより具体的に説明すると、光学構造体は、反射防止膜が形成された光学部材としてのΦ20mmの石英ガラス基板2を円環状のレンズ支持部材3の内壁に段部として形成された固定部3aにシリコン系の接着材1により固定し、シリコン系の接着材1の表面に、膜厚が200nmのNiからなる金属膜4を形成した構成である。

【0032】金属膜4はイオンビームスパッタ法を用いて無加熱で成膜した。成膜時には、上記石英ガラス基板2の有効光学径内にNi膜が成膜されないように、マスキングを行った。図2は、本発明にかかる第2の実施形態の光学構造体の概略断面図である。第2の実施形態の光学構造体は、光学部材2を支持部材3'の内壁に段部として形成された固定部3a'に接着材又は充填材1により固定し、接着材又は充填材1を覆って略密封された空間（密封空間）を形成するカバー5（以下、カバーという）を設けた構成である。カバー5は、光学部材2の周縁に形成された段部2aを上から押さえるようにビス6によって支持部材3'に締結される。

【0033】カバー5の材料としては、耐紫外線特性の良好なステンレス等の金属、SiC,SiN3等のセラミックスを用いることができるが、これに限定されない。本実施形態の場合も、カバー5は紫外線が接着材1に照射されるのを防止する遮光性を有し、接着材1から生じるアウトガスの飛散もある程度シールすることができる。

【0034】第2の実施形態をより具体的に説明すると、光学構造体は、反射防止膜が形成された光学部材としてのΦ20mmの石英ガラス基板2をレンズ支持部材3'の内壁に段部として形成された固定部3a'にシリコン系の接着材1により固定し、シリコン系の接着材1を覆う円環状のステンレス製のカバー5をビス6によりレンズ支持部材3'に固定した構成である。

【0035】本実施例では、接着材1がレンズ支持部材3'の固定部の上面3bより上にはみ出さないように、レンズ支持部材3'の上面3bは、上記石英ガラス基板2の周縁に設けられた段部2aよりも高くなるようにした。カバー5は、その他に露光光を遮蔽する遮蔽板であっても良い。図3は、本発明にかかる第3の実施形態の光学構造体の概略断面図である。

【0036】第3の実施形態の光学構造体は、第2の実施形態の光学構造体の構成のうちカバー5をガス導入管7'及びガス排出管7"付きの円環状のカバー7に置き換えた構成である。第3の実施形態をより具体的に示すと、光学構造体は、反射防止膜が形成された光学部材としてのΦ20mmの石英ガラス基板2をレンズ支持部材3'の内壁の段部として形成された固定部3a'にシリコン系の接着材1により固定し、シリコン系の接着材1を覆うガス導入管7'及びガス排出管7"付きのステンレス製の円環状のカバー7をビス6によりレンズ支持カバー3'に固定した構成である。

【0037】カバー7は、光学部材2の光学有効径外の端面を上から押さえるようにビス6によって支持部材3'に締結される。上記円環状のカバー7は、光学部材2の形状に沿って接するように設けられるが、わずかな隙間が生じる場合がある。そのため、上記構造により光学構造体を光洗浄する際に、ガス導入管7'からカバー7の密封空間7aに、カバー7の外側の圧力より少し高い圧力のガスを導入することにより、光洗浄の際に発生するオゾンと活性酸素が、密封空間7a内に入ってくることを防止することができる。

【0038】密封空間7a内に導入するガスとして、N_2、He、Ar等の不活性ガスやHe等で希釈したH_2を用いることができるが、これに限定されない。本実施形態の場

合も、カバー7は紫外線が接着材1に照射されるのを防止する遮光性を有し、接着材1から生じるアウトガスの飛散をある程度シールすることができる。

【0039】第1の実施形態～第3の実施形態で製作した複数の光学構造体を鏡筒8に組み込み、光学系を製作した。図4は、第1～第3の実施形態の光学構造体のいずれか、又はそれらのうちの2以上を組み合わせて鏡筒8に組み込んだ投影露光装置用光学系の概略断面図であり、図7は、第3の実施形態で製作した光学構造体を鏡筒に組み込んだ光学系（投影光学系）の一部を拡大した概略断面図である。

【0040】図4の投影光学系は複数の屈折素子（レンズエレメント）のみで構成されているが、複数の反射素子（ミラー等）のみで構成された投影光学系、及び複数の屈折素子と反射素子とを組み合わせて構成された投影光学系に対しても、第1～第3の実施形態のいずれかの光学構造体を適用できる。また、投影光学系の鏡筒は単一である必要はなく、複数の鏡筒を組み合わせてもよい。

【0041】投影光学系の鏡筒8内には、光軸に沿って複数個の光学部材2が所定の間隔を伴って積層されるが、複数の光学部材2の各間隔は、互いに隣接する2つの光学構造体の間に所定の厚さのレンズ間隔環9（ワッシャー）を入れて調整されている。また、本発明にかかる第1～第3の実施形態に示した光学構造体は、フォトレジストでコートされたウエハ上にマスク（レチクル）のパターンの像を投影するための投影光学系以外に、①ビームエクスパンダー、オプチカルインテグレータ（フライアイレンズ）、開口絞り（σ絞り）、視野絞り、及びコンデンサーレンズなどの複数の光学要素を有し、光源から射出される露光用照明光（露光光）でマスク（レチクル）を照射する照明光学系、②クリーンルームの床下に投影露光装置本体とは分離して配置される光源から射出される照明光をその本体内の照明光学系に導くとともに、照明光学系の光軸と照明光との位置関係を調整するための少なくとも1つの光学要素（可動ミラー等）を有する送光系、③マスク又は基板上のアライメントマークに紫外波長域の照明光（アライメント光）を照射してその位置を検出するアライメント光学系、及び④投影光学系の光学特性（例えば、焦点位置、投影倍率、ザイデルの5収差等）を検出するために、マスク又は基板を載置するステージ上の基準マーク、或いはマスク上の計測用マークに露光光又は露光光と略同一波長の照明光を照射し、該マークから発生して投影光学系を通る光を受光する計測用光学系等にも適用される。

【0042】図4に示す投影光学系について、光源が低圧水銀ランプである光洗浄装置を用いて、光洗浄を行った。光源が低圧水銀ランプである光洗浄装置に、上記光学系をそれ以外には光が照射されないように設置して、光洗浄を行った。この時、投影光学系の鏡筒8内は空気で満たされている。

【0043】ここでは、特に、第3の実施形態の光学部材2を鏡筒に組み込んだ光学系（光学系を投影露光装置内に組み込む前）を、その状態で光洗浄する手順を以下に示す。まず、図7に示すように、光学構造体のカバー7のガス導入管7'をガス供給源14に設けられたガス供給管12に接続し、ガス排出管7"をガス排出機構16に設けられたガス排出管15に接続した。ガスの導入及び排出の制御は、ガス供給管12及びガス排出管15にそれぞれ設けられているバルブ13、13'の開閉によって行う。

【0044】光源が低圧水銀ランプである光洗浄装置に、上記光学系以外には光が照射されないように設置して、低圧水銀ランプから放射される185nmと254nmの光を用いて光洗浄を行った。この時、光学系の鏡筒内は空気で満たされている。発明が解決しようとする課題で記載した様に、紫外線が直接接着材に照射されるのを防止するだけではなく、光洗浄の際にはオゾンと活性酸素が発生し、そのオゾンや活性酸素は接着材に悪い影響をあたえるので、オゾンや活性酸素から接着材を保護する必要があり、また、接着材に紫外線が照射されてアウトガスが発生してもそのガスが飛散するのを防止する必要があるので、カバー7の密封空間7aに、バルブ13を開いてガス供給源14からN_2ガスを鏡筒内の圧力（空気）より少し高い圧力で導入しつつ、バルブ13'を開いてガス排出機構16により排出を行って、密封空間7a内にN_2の流れを作り、オゾンや活性酸素がカバー7の密封空間7aに入り込まず、アウトガスをN_2の流れを用いて排出するようにした。

【0045】第1の実施形態～第3の実施形態の光学構造体を鏡筒に組み込んだ光学系は、上記の光洗浄を行っても、従来の光学構造体で問題になっているシリコン系接着材の劣化、及びシリコン系接着材からのアウトガスによる光学部材上への付着物が原因となって生じる透過率の低下が起こらず、レーザー耐久性の低下が発生せず、光学部材の良好な支持状態、光学特性を維持することができた。

【0046】図5は、本発明にかかる投影露光装置の基本構造を示した図である。図5に示すように、本発明にかかる投影露光装置は、少なくとも、感光材を塗布した基板W（ウエハ）を載置するウエハステージ23、露光光をマスク（レチクルR）に照射する照明光学系21、照明光学系21に露光光を供給するためのエキシマレーザー等の光源100、及びウエハWとレチクルRとの間に配置される投影光学系25を有する。投影光学系25の物体面（P1）には、レチクルRの表面（パターン形成面）がくるように配置され、投影光学系25の像面（P2）には、ウエハWの表面がくるように配置されている。

【0047】また、レチクルRは、レチクルステージ2

2上に配置され、レチクルR上のパターンを投影光学系25を介してウエハステージ23上に載置されたウエハWに投影露光する構成となっている。レチクルR交換系200は、レチクルステージ22にセットされたレチクルRの挿脱及び交換を行うとともに、レチクルステージ22とレチクルカセットとの間でレチクルRの搬送を行う機能を有する。

【0048】さらに、投影光学系内には、図6に示すように、投影露光装置に設けられたN_2供給源11から供給管10を通してN_2が供給され、支持部材3、3'の各々に設けられた貫通孔を通ってN_2が全体にいきわたる、即ち、互いに隣接する2つのレンズエレメントに挟まれた略密封された空間のそれぞれに供給される構成となっている。

【0049】尚、図示していないが、光源100とレチクルRとの間に配置される照明光学系21を1つ、又は複数の鏡筒8に収納し、図6と同様の構成で鏡筒8内にN_2を供給するように構成されている。第1の実施形態及び／または第2の実施形態の光学構造体を組み込んだ図4に示す光学系を、図5に示すような光源がArFエキシマレーザー（波長λ=193nm）である投影露光装置の投影光学系25として用いたところ（鏡筒8内には、図6に示すように投影露光装置に設けられたN_2供給源11から供給管10を通してN_2が導入され、レンズ支持部材3、3'に設けられた貫通孔を通ってN_2が全体にいきわたっている。）、同様に良好な結果が得られた。

【0050】このように第1の実施形態、第2の実施形態で製作した光学構造体を鏡筒に組み込んだ光学系は、最終的に投影露光装置に組み込む直前に光洗浄することが可能であり、また光学系を投影露光装置に組み込んだ後においても、光洗浄することが可能である。そのため、光学部材の本来の透過率を維持することができるので、光学部材が投影露光装置に組み込まれた際に、紫外線を照射しても透過率が低下しない。

【0051】また、第3の実施形態の光学構造体を組み込んだ図4に示す光学系を、図5に示すような光源がArFエキシマレーザー（波長λ=193nm）である投影露光装置の投影光学系25として用いた。投影露光装置には、図7に示すように、光学系25内の光学構造体のカバー7の密封空間7aにガスを供給するバルブ13付きガス供給管12及びガス供給源14と、バルブ13'付きガス排出管15及びガス排出機構16とが設けられている。

【0052】図6に示すように、投影光学系の鏡筒8内には、投影露光装置に設けられたN_2供給源11から供給管10を通してN_2が導入され、レンズ支持部材3'の各々に設けられた貫通孔を通ってN_2が全体にいきわたっているので、ArFレーザーの照射は、N_2雰囲気中で行われ、ArFレーザーの吸収（減衰）は最小限に抑えられる。そのため、この状態で光（ArFレーザー）洗浄する場合には、鏡筒8内に導入されているN_2の圧力よりも高い圧力のN_2ガスを、バルブ13を開いて、ガス供給源14からカバー7の密封空間7aに導入しつつ、バルブ13'を開いてガス排出機構16により排出を行って密封空間7a内にN_2の流れを作り、鏡筒8内で光洗浄の際に発生するオゾン、活性酸素のうち密封空間7a内に入り込んでくるオゾン、活性酸素を排出する、或いは前述した密封空間7a内に入り込んでくるオゾン、活性酸素をバルブ13'を開いてガス排出機構16により強制排出してオゾン、活性酸素が接着材と反応するのを防止する。

【0053】上記光学系のArFエキシマレーザーによる光洗浄を行った。上記と同様に、良好な結果が得られた。ArFエキシマレーザーの他に、ArFエキシマレーザーと切り替えが可能な光洗浄用の低圧水銀ランプを設けて、光洗浄を行っても良い。このように第3の実施形態で製作した光学構造体を鏡筒8に組み込んだ光学系は、最終的に投影露光装置に組み込む直前に光洗浄することが可能であり、また光学系を投影露光装置内に組み込んだ後においても、光洗浄することが可能である。

【0054】但し、後者の場合には、光学構造体のカバー7の密封空間7aにガスを供給するバルブ13付きガス供給管12及びガス供給源14と、バルブ13'付きガス排出管15及びガス排出機構16とを投影露光装置に設けておくことが望ましい。また、照明光学系内に配置される光学素子により露光光の一部を分岐して光電検出器で受光する場合、照明光学系内の光学素子と光電検出器との間に配置される光学部材、及び／又は光電検出器を支持部材に固定する接着材又は充填材に本発明の保護部材又は遮蔽部材を設けてもよい。この場合にも、露光光が接着材又は充填材に照射されることがなく、接着材又は充填材からのアウトガスの発生を防止できる。従って、接着材又は充填材に起因して生じる有機物等の異物が光学部材や光電検出器（受光面）に付着したり、光路中に進入（浮遊）することがなく、常に精度良く受光光量（強度）を検出することができる。

【0055】さらに、照明光学系ではレンズエレメントやミラー以外の光学部材、例えば干渉フィルターなどにも本発明は適用できる。そのため、光学部材の本来の透過率を維持することができるので、光学部材が投影露光装置に組み込まれた際に、紫外線を照射しても透過率又は反射率が低下しない。

【0056】

【発明の効果】以上、説明したように、本発明にかかる光学構造体及びそれを組み込んだ光学系は、紫外線を露光光とする投影露光装置の光学系内で使用しても光学性能を維持し、光学部材の劣化が生じることがない。また、本発明にかかる光学構造体は、支持部材に組み込まれた状態における光学部材、光学構造体を鏡筒に組み込んだ状態（光学系）における光学部材及び光学系を投影

露光装置内に組み込んだ状態における光学部材の光洗浄が可能である。

【0057】そのため、光学部材の本来の透過率を維持することができるので、光学部材が投影露光装置に組み込まれた際に、紫外線を照射しても透過率が低下しない。

【図面の簡単な説明】

【図1】第1の実施形態の光学構造体の概略断面図である。

【図2】（a）は第2の実施形態の光学構造体の斜視分解図であり、（b）はそれらを組み込んだ状態におけるX－X'矢視断面図である。

【図3】第3の実施形態の光学構造体の概略断面図である。

【図4】第1の実施形態～第2の実施形態で製作した光学構造体のいずれか、又はそれらのうち2つ以上を組み合わせ鏡筒に組み込んだ光学系の概略断面図である。

【図5】本発明にかかる投影露光装置の基本構造を示す概略図である。

【図6】図2で示した光学系を投影露光装置の光学系として用いた場合の概略断面図である。

【図7】第3の実施形態で製作した光学構造体を鏡筒に組み込んだ光学系（投影光学系）の一部を拡大した概略断面図である。

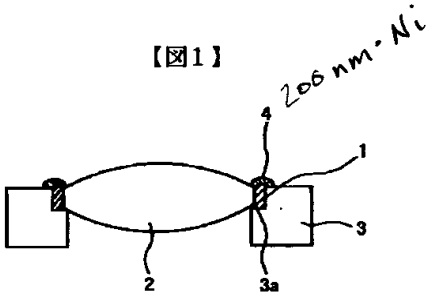
【図8】従来の光学構造体の概略断面図である。

【符号の説明】

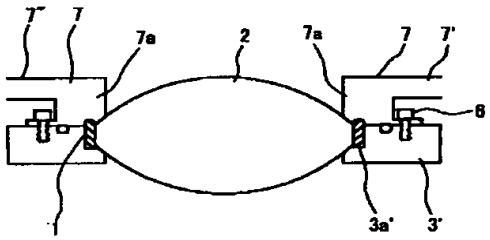
1・・・接着材又は充填材
2・・・光学部材

3、3'・・・支持部材（レンズ支持部材）
3a、3a'・・・光学部材固定部（固定部）
3b・・・支持部材（レンズ支持部材）の上面
4・・・金属膜
5・・・カバー
6・・・ビス
7・・・ガス導入管及びガス排出管付きカバー
7a・・・密封空間
8・・・鏡筒
9・・・レンズ間隔環（ワッシャー）
10・・・窒素供給管
11・・・窒素供給源
12・・・ガス供給管
13、13'・・・バルブ
14・・・ガス供給源
15・・・ガス排出管
16・・・ガス排出機構
21・・・照明光学系
22・・・レチクルステージ
23・・・ウエハステージ
25・・・投影光学系
100・・・光源
200・・・レチクル交換系
300・・・ステージ制御系
400・・・主制御部
W・・・基板（ウエハ）
R・・・マスク（レチクル）

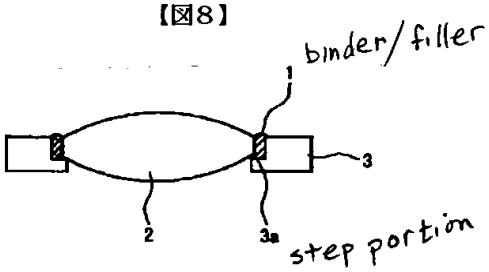
【図1】



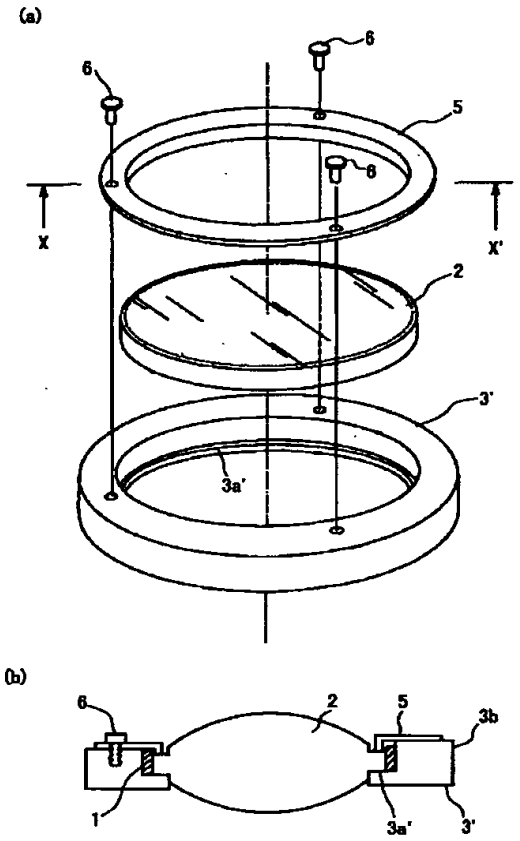
【図3】



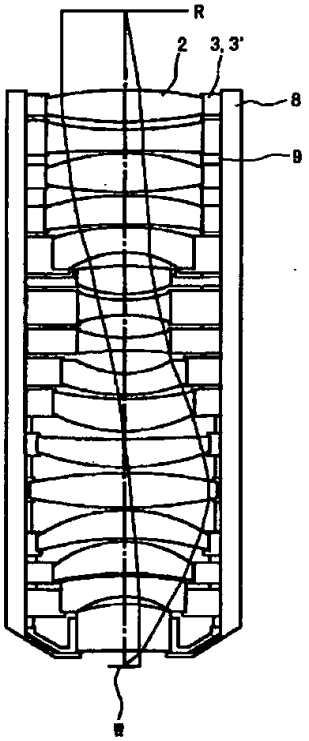
【図8】



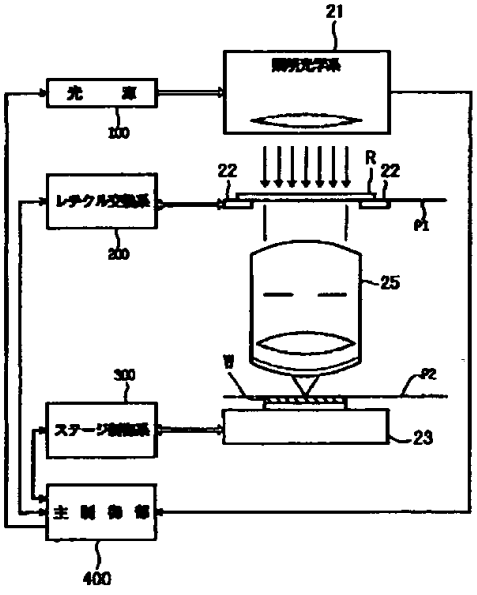
【図2】


(a)
6
6
5
6
X
X'
2
3'
3a'
(b)
6
2
5
3b
1
3a'
3'

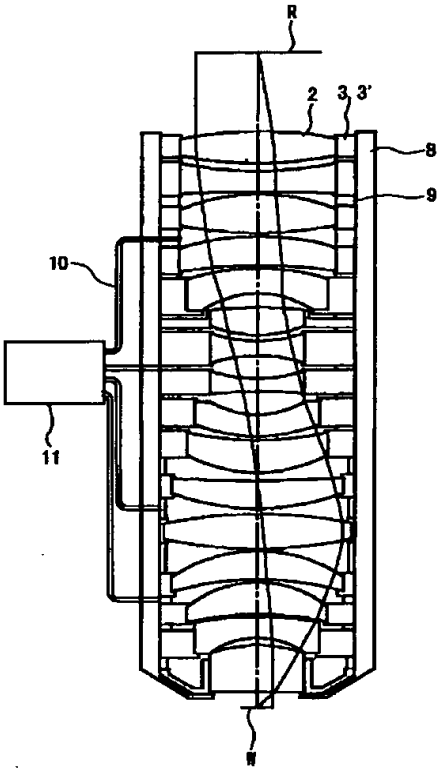
【図4】


R
2
3, 3'
8
9
W

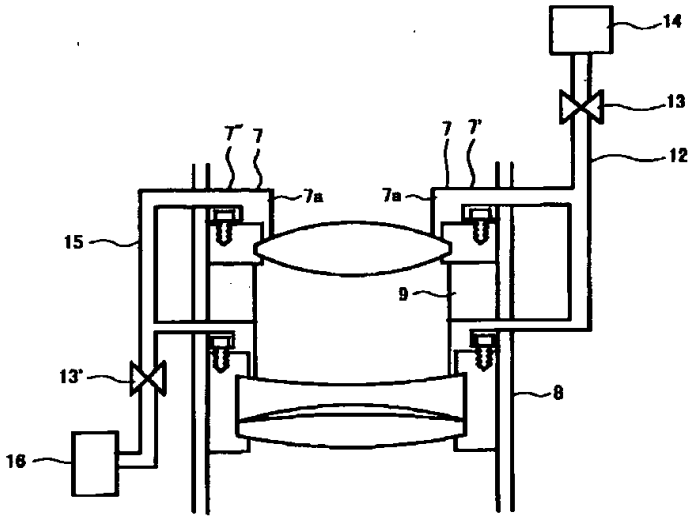
【図5】


21
光　源
100
22
R
22
P1
200
25
W
300
P2
23
400

【図6】



【図7】



PATENT ABSTRACTS OF JAPAN

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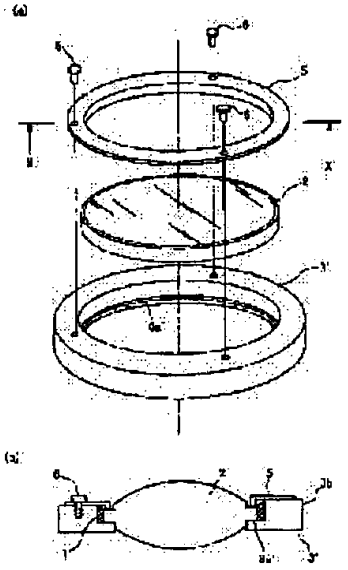
NISHI TAKECHIKA

(54) OPTICAL STRUCTURAL BODY, PROJECTION EXPOSING OPTICAL SYSTEM INCORPORATING THE SAME AND PROJECTION ALIGNER

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent the fluctuation of optical characteristics of an optical member due to the irradiation of a radiant beam by providing a protective member on the surface of adhesive or a filling material.
SOLUTION: A quartz glass substrate 2 as optical member on which an antireflection film is formed is fixed to the fixing part 3a' formed as a stepped part on the inner wall of a lens supporting member 3' with a silicon-compound adhesive 1 and an annular stainless cover 5 covering the adhesive 1 is fixed to the supporting member 3' by screws 6. In this case, the upper surface 3b of the fixing part of the supporting member 3' is made higher than the stepped part provided at the surroundings of the quartz glass substrate 2 so that the adhesive 1 is not protruded higher than the upper surface 3b. Then, the metal of tainless whose ultraviolet ray-resistance is satistactory or the like, or ceramics of SiC or the like is used as the material of the cover 5. The cover 5 has a light shielding property preventing the adhesive 1 from being irradiated with the ultraviolet rays and it can seal the scattering of out-gas to be generated from the adhesive 1 to some extent.



LEGAL STATUS

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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The optical structure characterized by preparing a protection member in the front face of the aforementioned binder or a filler in the optical structure which comes to fix at least one optical member to supporter material with a binder or a filler.
[Claim 2] The optical structure characterized by having the covered member which prevents generating of the gas from the aforementioned binder by the irradiation to the aforementioned binder or filler of the aforementioned light beam or this irradiation or a filler in the optical structure which comes to fix to supporter material the optical member by which a light beam is irradiated with a binder or a filler.
[Claim 3] the aforementioned protection -- the optical structure according to claim 1 or 2 characterized by a member or the aforementioned covered member being a thin film
[Claim 4] The optical structure according to claim 3 characterized by being the metal membrane in which the aforementioned thin film contained one or more components chosen from the group of nickel, Si, Au, Pt, W, Mo, Cr, Ti, aluminum and these alloys, or a compound.
[Claim 5] the aforementioned protection -- the optical structure according to claim 1 or 2 characterized by having covering which forms the space by which the member or the aforementioned covered member covered the aforementioned binder or the filler, and abbreviation seal was carried out, the gas introduction pipe which introduces gas into this seal space, and the gas exhaust pipe which discharges gas from the seal space
[Claim 6] The optical structure according to claim 5 characterized by the aforementioned gas introduced into the aforementioned seal space being the mixed gas containing two or more kinds of gas by which it was chosen from the gas by which it was chosen either or these gas of N2, Ar, helium, and H2.
[Claim 7] Optical system for projection aligners with which the optical structure according to claim 1 to 6 was incorporated.
[Claim 8] The projection aligner characterized by using the optical system for projection aligners according to claim 7 for the aforementioned lighting optical system or the aforementioned projection optical system in the projection aligner possessing the lighting optical system which illuminates a mask, and the projection optical system for carrying out projection exposure of the pattern formed in the aforementioned mask on a substrate.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the optical system for projection aligners incorporating the optical structure and it suitable for irradiation and optical washing of ultraviolet rays.
[0002]
[Description of the Prior Art] Since the degree of integration of a semiconductor device is increased in recent years, the demand of a raise in the resolution of the reduction projection aligner for semiconductor manufacture (henceforth a projection aligner) is increasing. Short wavelength-ization of light source wavelength is mentioned as one method of raising the resolution of the photo lithography by this projection aligner. Then, the aligner which used as the light source the excimer laser which has an oscillation spectrum is beginning to be used for an ultraviolet-rays field (lambda<=350nm).
[0003] Although the optical faculty material 2 (a lens, mirror, etc.) which constitutes optical system, such as a projection aligner, is used being fixed to fixed part (step) 3a of the supporter material 3 in a circle as shown in drawing 8 In order to fix the peripheral face of the optical faculty material 2 to fixed part 3a in the supporter material 3, generally the binder or the filler 1 is used (these (1-3, 3a) are hereafter called "optical structure" collectively). In the case of the optical structure especially used for a precision mechanical equipment like a projection aligner, the binder or filler 1 of a silicon system is used so that the optical faculty material 2 held at fixed part 3a may not deform.
[0004]
[Problem(s) to be Solved by the Invention] By the way, within a projection aligner and its optical system, ultraviolet rays are irradiated by the scattering phenomenon by places other than the portion (optical path formed by the optical member) along which light passes on geometry and wave optics. Moreover, when an optical member is included in a projection aligner and ultraviolet rays are irradiated, change of permeability (or reflection factor) cannot attain the permeability (or reflection factor) computed from the property of optical faculty material original. That is, the contamination by the organic substance of optical faculty material etc. became a cause in process in which an optical member is included in a projection aligner, and the above-mentioned problem has arisen.
[0005] Recently not to mention optical washing by the manufacturing process of optical faculty material Therefore, the inclusion process to the supporter material of optical faculty material, The inclusion process to the lens-barrel of the supporter material (supporter material in which the optical member was included), And optical washing at the inclusion process to the projection aligner of the lens-barrel (optical system), That is, the need for optical washing of the optical member in the state where it was included in supporter material, the optical member in the state where it was included in the lens-barrel, and the optical faculty material in the state where it was incorporated in the projection aligner has come to be cried for.
[0006] The most effective thing is optical washing using the light (185nm and 254nm) emitted from a low-pressure mercury lamp among the optical washing. If the mechanism of optical washing is explained briefly, oxygen (O2) absorbs 185nm light, turns into active oxygen, and a part of the active oxygen will react with oxygen, and it will become ozone (O3). Moreover, ozone absorbs 254nm light and generates active oxygen and oxygen.
[0007] Thus, the organic substance on a washed object oxidizes and is washed by the ozone and active oxygen which were generated. However, if ultraviolet rays are irradiated or the binder and filler of a silicon system which fix an optical member to the fixed part of supporter material are **(ed) by the gas which occurs in the case of optical washing, such as ozone and active oxygen, transformation will take place and the fall of adhesive strength and change of an elastic force will take place.
[0008] Moreover, transformation of this binder and filler changes the support state of optical faculty material, or becomes the cause which makes unnecessary stress give and deform into an optical member. Furthermore, if ultraviolet rays are irradiated or the binder and filler of a silicon system are **(ed) by the gas which occurs in the case of optical washing, such as ozone and active oxygen, out gas will generate them. this out gas (molecule) that occurred -- optics -- a member -- the affixes (organic substance etc.) which adhere upwards cause [of the ultraviolet rays irradiated from the light source] absorption
[0009] these affixes (organic substance etc.) -- out gas (molecule) -- optics -- a member -- the case where it is adhered and formed upwards, and out gas -- the inside of a gas -- reacting -- the reactant -- optics -- a member -- the case where it is formed upwards can be considered In using ultraviolet rays for the projection aligner made into exposure light especially, when the out gas from the binder and filler of a silicon system by which the excimer laser was irradiated adheres to the front face of optical faculty material, it causes the fall of the endurance of optical faculty material.

[0010] Thus, the present condition of the binder and filler of a silicon system is that what has the property which was excellent more than it as a material with which a problem fixes the optical member of a certain thing to a metal and the supporter material of ceramics does not exist at ultraviolet-rays-proof nature, and anti-oxidation and corrosion gas nature. then, the optics according this invention] to irradiation of a radiation beam (for example, light beam with a wavelength of 350nm or less) -- it aims at offering the optical structure and optical system which can prevent change of the optical property (for example, permeability or a reflection factor) of a member, and a projection aligner Furthermore, also let it be the purpose to offer the optical structure which can carry out optical washing of the optical member fixed to supporter material or the lens-barrel with the binder or the filler, the optical member included in the optical system which consists of two or more optical elements, and the optical member of the optical system built into the projection aligner, optical system, and a projection aligner.

[0011]

It is means] in order to solve [technical problem. this invention -- the first -- "-- at least one optics -- the optical structure which comes to fix a member 2 to the supporter material 3 and 3' with a binder or a filler 1 -- setting -- the front face of the aforementioned binder or a filler 1 -- protection -- optical structure (claim 1)" characterized by forming members 4, 5, and 7 is offered

[0012] Since the optical structure according to claim 1 prepared the protection member in the front face of a binder or a filler, the light beam of an ultraviolet wavelength region is not irradiated by the binder or filler. Therefore, generating of the out gas from a binder or a filler can be prevented, and foreign matters, such as the organic substance, do not adhere to the front face of optical faculty material. Thereby, change of the optical properties (permeability, reflection factor, etc.) of the optical faculty material accompanying irradiation of a light beam can be prevented. Moreover, it becomes possible to perform optical washing which removes the matter (for example, water, a hydrocarbon, or matter that diffuses light beams other than these) which irradiated the light beam (185nm and 254nm) at the optical member, and adhered to the front face, fixing an optical member on supporter material with a binder or a filler.

[0013] Moreover, this invention is set to the optical structure which comes to fix to the supporter material 3 and 3' the optical faculty material 2 by which "light beam is irradiated by the second with a binder or a filler 1. the cover which prevents generating of the gas from the aforementioned binder by the irradiation to the aforementioned binder or filler 1 of the aforementioned light beam or this irradiation or a filler 1 -- optical structure (claim 2)" characterized by having members 4, 5, and 7 is offered

[0014] Since the optical structure according to claim 2 prepared the covered member which prevents generating of the out gas from the binder by the irradiation to the binder or filler of a light beam or this irradiation or a filler, foreign matters, such as the organic substance which originates in a binder or a filler and is produced, do not adhere to the front face of optical faculty material, and it can prevent change of the optical properties (permeability, reflection factor, etc.) of the optical faculty material accompanying irradiation of a light beam. Moreover, it also becomes possible to perform optical washing, fixing an optical member on supporter material with a binder or a filler.

[0015] moreover, this invention -- the third "-- the aforementioned protection -- optical structure (claim 3)" according to claim 1 or 2 characterized by a member or the aforementioned covered member being a thin film 4 is offered the optical structure according to claim 3 -- protection -- since the member or the covered member was made into the thin film 4, an operation according to claim 1 or 2 can be done so with the easy structure which forms a thin film on a binder or a filler

[0016] Moreover, this invention provides the fourth with "the optical structure (claim 4) according to claim 3 characterized by being the metal membrane in which the aforementioned thin film 4 contained one or more components chosen from the group of nickel, Si, Au, Pt, W, Mo, Cr, Ti, aluminum and these alloys, or a compound." Since the optical structure according to claim 4 made the thin film the metal membrane, it can prevent generating of the out gas from the binder by the irradiation to the binder or filler of a light beam or this irradiation or a filler to abbreviation completeness, and does so an operation according to claim 1 or 2.

[0017] moreover -- this invention -- the -- five -- "-- the above -- protection -- a member -- or -- the above -- cover -- a member -- the above -- a binder -- or -- a filler -- one -- covering -- abbreviation -- seal -- carrying out -- having had -- space -- forming -- covering -- seven -- this -- seal -- space -- seven -- a -- gas -- introducing -- gas -- introduction -- a pipe -- seven -- ' -- the -- seal -- space -- seven -- a -- from

[0018] The optical structure according to claim 5 The irradiation to the binder or filler of a light beam, or the protection which prevents generating of the out gas from the binder by this irradiation or a filler -- a member or a covered member with covering which forms the space by which covered the binder or the filler and abbreviation seal was carried out Since it has the gas introduction pipe which introduces gas into this seal space, and the gas exhaust pipe which discharges gas from the seal space The ozone generated in the case of washing and active oxygen can prevent entering in seal space by introducing gas into seal space from a gas introduction pipe, and discharging gas from a gas exhaust pipe.

[0019] Moreover, this invention provides the sixth with "the optical structure (claim 6) according to claim 5 characterized by the aforementioned gas introduced into the aforementioned seal space 7a being the mixed gas containing two or more kinds of gas by which it was chosen from the gas by which it was chosen either or these gas of N2, Ar, helium, and H2." The ozone generated in the case of washing and active oxygen can prevent entering in seal space, without reacting with a binder or a filler, since the optical structure according to claim 6 introduced into seal space the mixed gas in which gas contains two or more kinds of gas by which it was chosen from the gas by which it was chosen either or these gas of N2, Ar, helium, and H2.

[0020] Moreover, this invention provides the seventh with "the optical system for projection aligners (claim 7) with which the optical structure according to claim 1 to 6 was incorporated." The optical structure indicated by either of the claims 1-6 For

example, a semiconductor device, Since it is included in the optical system carried in the projection aligner used at the lithography process which manufactures micro devices, such as the thin film magnetic head and an image pck-up element (CCD) Exposure light (for example, an ArF excimer laser with a wavelength of 193nm or a KrF excimer laser with a wavelength of 248nm etc.), alignment light, etc. of an ultraviolet wavelength region are not irradiated by the binder or filler, and generating of the out gas from a binder or a filler can be prevented. Therefore, foreign matters, such as the organic substance which originates in a binder or a filler and is produced, do not adhere to the front face of optical faculty material, and change of the optical properties (permeability, reflection factor, etc.) of optical faculty material can be prevented. Moreover, where an optical member is included in optical system (lens-barrel), optical washing can be performed, and it becomes possible to remove the above-mentioned matter adhering to the front face.

[0021] The optical system with which the optical structure of this invention is incorporated has two or more optical elements, such as for example, an optical integrator (fly eye lens) and a condenser lens, consists of lighting optical system which irradiates a mask with exposure light, and two or more optical elements (both a refraction element, a reflective element or a refraction element, and a reflective element) arranged along with an optical axis, and has the projection optical system which projects the image of the pattern formed in the mask on substrates (semiconductor wafer etc.). Furthermore, while leading the lighting light injected from the light source arranged by dissociating with a projection-aligner main part in the under floor of a clean room, for example to the lighting optical system in the main part The light transmission system which has at least one optical elements (movable mirror etc.) for adjusting the physical relationship of the optical axis of lighting optical system, and lighting light, In order to detect the optical properties (for example, a focal position, a projection scale factor, the Seidel's five aberrations, etc.) of the alignment optical system which irradiates the lighting light of an ultraviolet wavelength region at the alignment mark on a mask or a substrate, and detects the position, and a projection optical system Exposure light or exposure light, and the lighting light of abbreviation same wavelength are irradiated at the reference mark on the stage in which a mask or a substrate is laid, or the mark for measurement on a mask, and there is optical system for measurement which receives the light which occurs from this mark and passes along a projection optical system.

[0022] Decline in the permeability of the optical faculty material in a light transmission system or a reflection factor can be prevented, while suppressing the attenuation (on-the-strength fall) of lighting light which carries out incidence to lighting optical system, it is made to inject lighting light from the light source in advance of exposure operation, in including the optical structure of this invention in the above-mentioned light transmission system, namely, it becomes possible by performing optical washing to remove the above-mentioned foreign matter adhering to the optical member.

[0023] Moreover, when including the optical structure of this invention in the above-mentioned alignment optical system, the lighting luminous-intensity change by change of the permeability of optical faculty material or a reflection factor irradiated by the alignment mark can be prevented. Furthermore, while being able to prevent the fall of illuminance homogeneity of the lighting light on an alignment mark by the reactant by which alert gas or out gas reacts and is generated in a gas (generating of illuminance unevenness), collapse (degradation) of the telecentricity of the lighting light by the homogeneous fall of the optical intensity in the field through which the lighting flux of light gathering in one on the alignment mark on the pupil surface of alignment optical system passes can also be prevented. Therefore, it becomes possible not to reduce the position detection precision of an alignment mark and to carry out alignment of a mask and the substrate with high precision.

[0024] Furthermore, as well as alignment optical system when including the optical structure of this invention in the above-mentioned measurement optical system, the lighting luminous-intensity change on a mark by change of the permeability of optical faculty material or a reflection factor and the fall of illuminance homogeneity or telecentricity can be prevented. Therefore, it becomes possible to detect the optical properties (for example, a focal position, a projection scale factor, the Seidel's five aberrations, etc.) of a projection optical system with high precision.

[0025] Moreover, this invention provides the eighth with "the projection aligner (claim 8) characterized by using the optical system for projection aligners according to claim 7 for the aforementioned lighting optical system 21 or the aforementioned projection optical system 25 in the projection aligner possessing the lighting optical system 21 which illuminates a mask, and the projection optical system 25 for carrying out projection exposure of the pattern formed in the aforementioned mask R on Substrate W."

[0026] Since optical system according to claim 7 is built into the lighting optical system or the projection optical system of a projection aligner, exposure light is not irradiated by a binder or the filler and generating of the out gas from a binder or a filler can be prevented. Therefore, foreign matters, such as the organic substance which originates in a binder or a filler and is produced, can adhere to the front face of optical faculty material, or it does not advance into a lighting optical path or an image formation optical path (suspension), and change of the optical properties (permeability, reflection factor, etc.) of lighting optical system and a projection optical system can be prevented. Moreover, where lighting optical system and a projection optical system are included in a projection aligner, optical washing of optical faculty material can be performed, and it becomes possible to remove the above-mentioned matter adhering to the front face.

[0027] Furthermore, the lighting luminous-intensity change on the mask by change of the permeability of lighting optical system or a projection optical system or a reflection factor or a substrate can be prevented, and it becomes possible to imprint the pattern of a mask on a substrate with always proper light exposure. Furthermore, are based on the reactant by which out gas or out gas reacts and is generated in a gas. The fall of illuminance homogeneity of the lighting light on a mask or a substrate, and the optical property of a projection optical system (For example, change of a focal position, a projection scale factor, the Seidel's five aberrations, telecentricity, etc.) can be prevented, and it becomes possible to manufacture micro devices, such as a semiconductor

device which projects a pattern image on a substrate in the state of always good image formation, and satisfies an expected property.

[0028] moreover, the optical member arranged between the optical element in lighting optical system, and a photodetector when branching in a part of exposure light by the optical element arranged in lighting optical system and receiving light with a photodetector and/or the binder which fixes a photodetector to supporter material, or a filler -- protection of this invention -- you may prepare a member or a covered member Also in this case, exposure light is not irradiated by a binder or the filler and generating of the out gas from a binder or a filler can be prevented. Therefore, foreign matters, such as the organic substance which originates in a binder or a filler and is produced, can adhere to an optical member or a photodetector (light-receiving side), or it cannot advance into an optical path (suspension) and the light-receiving quantity of light (intensity) can always be detected with a sufficient precision.

[0029]

[The operation gestalt of invention] Hereafter, the optical structure of the operation gestalt concerning this invention is explained, referring to a drawing. Drawing 1 is the outline cross section of the optical structure of the 1st operation gestalt concerning this invention. The optical structure of the 1st operation gestalt is the composition which fixed the optical member (****** material, such as a lens and a mirror) 2 to fixed part 3a formed in the wall of the supporter material 3 as a step with the binder or the filler 1, and formed the metal membrane 4 in the exposure front face of the binder or a filler 1.

[0030] It is desirable to use the metal membrane which contained one or more components chemically chosen from the group of stable and precise nickel, Si, Au, Pt, W, Mo, Cr(s), Ti and aluminum and these alloys, or a compound as a metal membrane 4. By making it suitable thickness, these metal membranes have good shading nature to ultraviolet rays, and carry out the seal of the scattering of out gas simultaneously. moreover -- although membrane formation can be performed by the vacuum deposition method, the spatter, etc. -- optics -- in order to form membranes by the service temperature of no heating or optical system so that deformation of a member 2 may not occur, and to avoid transformation of a binder 1 further, it is desirable to adopt the forming-membranes method which is not **(ed) by plasma

[0031] In addition, when a binder and a filler 1 are formed over the perimeter in alignment with the periphery end face of the optical faculty material 2, a metal membrane is formed all over the. When the 1st operation form is explained more concretely, the optical structure The 20mm quartz-glass substrate 2 is fixed to fixed part 3a formed in the wall of the lens supporter material 3 in a circle as a step by the binder 1 of a silicon system. ** as an optical member in which the antireflection film was formed -- It is the composition in which the metal membrane 4 which consists of nickel whose thickness is 200nm was formed on the front face of the binder 1 of a silicon system.

[0032] The metal membrane 4 formed membranes by no heating using the ion beam spatter method. At the time of membrane formation, it masked so that nickel film might not be formed in the diameter of effective optics of the above-mentioned quartz-glass substrate 2. Drawing 2 is the outline cross section of the optical structure of the 2nd operation form concerning this invention. the optical structure of the 2nd operation form -- optics -- it is the composition of having formed the covering 5 (henceforth covering) which forms the space (seal space) by which fixed the member 2 to fixed part 3a' formed in the wall of supporter material 3' as a step with the binder or the filler 1, covered the binder or the filler 1, and abbreviation seal was carried out Covering 5 is concluded by supporter material 3' on a screw 6 so that step 2a formed in the periphery of the optical faculty material 2 may be pressed down from a top.

[0033] Although the ceramics of metals, such as stainless steel with a good ultraviolet-rays-proof property, SiC, and SiN3 grade can be used as a material of covering 5, it is not limited to this. Also in this operation gestalt, ultraviolet rays have the shading nature which prevents that a binder 1 irradiates, and covering 5 can carry out the seal also of the scattering of the out gas produced from a binder 1 to some extent.

[0034] When the 2nd operation form is explained more concretely, the optical structure The 20mm quartz-glass substrate 2 is fixed to fixed part 3a' formed in the wall of lens supporter material 3' as a step by the binder 1 of a silicon system. ** as an optical member in which the antireflection film was formed -- It is the composition which fixed the covering 5 made from wrap annulus ring-like stainless steel to lens supporter material 3' for the binder 1 of a silicon system on the screw 6.

[0035] It was made for upper surface 3b of lens supporter material 3' to become higher than step 2a prepared in the periphery of the above-mentioned quartz-glass substrate 2 in this example, so that a binder 1 may not overflow above upper surface 3b of the fixed part of lens supporter material 3'. Covering 5 may be a shield which covers exposure light in addition to this. Drawing 3 is the outline cross section of the optical structure of the 3rd operation gestalt concerning this invention.

[0036] the optical structure of the 3rd operation gestalt -- the inside of the composition of the optical structure of the 2nd operation gestalt -- covering 5 -- gas introduction pipe 7' and gas exhaust pipe 7" -- it is the composition replaced with the covering 7 of a with in a circle When the 3rd operation gestalt is shown more concretely, the optical structure The 20mm quartz-glass substrate 2 is fixed to fixed part 3a' formed as a step of the wall of lens supporter material 3' by the binder 1 of a silicon system. ** as an optical member in which the antireflection film was formed -- the binder 1 of a silicon system -- wrap gas introduction pipe 7' and gas exhaust pipe 7" -- it is the composition which fixed the covering 7 of the product made from stainless steel of a with in a circle to lens support covering 3' on the screw 6

[0037] Covering 7 is concluded by supporter material 3' on a screw 6 so that the end face besides the optical effective diameter of the optical faculty material 2 may be pressed down from a top. Although the covering 7 of the shape of an above-mentioned annulus ring is formed so that it may touch in accordance with the configuration of the optical faculty material 2, few crevices may produce it. Therefore, in case optical washing of the optical structure is carried out according to the above-mentioned structure,

the ozone generated in the case of optical washing and active oxygen can prevent entering in seal space 7a by introducing the gas of a pressure somewhat higher than the pressure of the outside of covering 7 into seal space 7a of covering 7 from gas introduction pipe 7'.
[0038] Although H2 diluted with inert gas, heliums, etc., such as N2, helium, and Ar, can be used as gas introduced in seal space 7a, it is not limited to this. Also in this operation form, covering 7 has the shading nature to which ultraviolet rays prevent that a binder 1 irradiates, and the seal of the scattering of the out gas produced from a binder 1 can be carried out to some extent.
[0039] operation form [of ** a 1st] - two or more optical structures manufactured with the 3rd operation form were included in the lens-barrel 8, and optical system was manufactured drawing 4 -- the 1- it is either of the optical structures of the 3rd operation form, or the outline cross section of the optical system for projection aligners built into the lens-barrel 8 or more [of them] combining two, and drawing 7 is the outline cross section to which some optical system (projection optical system) which included the optical structure manufactured with the 3rd operation form in the lens-barrel was expanded
[0040] the projection optical system which plurality reflective-elements(mirror etc.)-accepted it, came out, and was constituted although plurality refraction-element(lens-element)-accepted the projection optical system of drawing 4 , it came out of it and it was constituted, and the projection optical system constituted combining two or more refraction elements and reflective elements -- also receiving -- the 1- one optical structure of the 3rd operation form is applicable Moreover, the lens-barrel of a projection optical system does not need to be single, and may combine two or more lens-barrels.
[0041] the inside of the lens-barrel 8 of a projection optical system -- an optical axis -- meeting -- two or more optics -- although the laminating of the member 2 is carried out with a predetermined interval -- two or more optics -- between the two optical structures which adjoin mutually, each interval of a member 2 puts in the lens interval ring 9 (washer) of predetermined thickness, and is adjusted moreover, the 1- concerning this invention -- the optical structure shown in the 3rd operation form In addition to the projection optical system for projecting the image of the pattern of a mask (reticle) on the wafer by which the coat was carried out by the photoresist ** A beam expander, an optical integrator (fly eye lens), It has two or more optical elements, such as an aperture diaphragm (sigma drawing), a field diaphragm, and a condenser lens. The lighting optical system which irradiates a mask (reticle) with the lighting light for exposure (exposure light) injected from the light source, ** While leading the lighting light injected from the light source arranged by dissociating with a projection-aligner main part in the under floor of a clean room to the lighting optical system in the main part The light transmission system which has at least one optical elements (movable mirror etc.) for adjusting the physical relationship of the optical axis of lighting optical system, and lighting light, ** The alignment optical system which irradiates the lighting light (alignment light) of an ultraviolet wavelength region at the alignment mark on a mask or a substrate, and detects the position, And in order to detect the optical properties (for example, a focal position, a projection scale factor, the Seidel's five aberrations, etc.) of ** projection optical system Exposure light or exposure light, and the lighting light of abbreviation same wavelength are irradiated at the reference mark on the stage in which a mask or a substrate is laid, or the mark for measurement on a mask, and it is applied to the optical system for measurement which receives the light which occurs from this mark and passes along a projection optical system.
[0042] About the projection optical system shown in drawing 4 , optical washing was performed using the optical washing station whose light source is a low-pressure mercury lamp. The above-mentioned optical system was installed in the optical washing station whose light source is a low-pressure mercury lamp so that light might not be irradiated other than it, and optical washing was performed to it. At this time, the inside of the lens-barrel 8 of a projection optical system is filled with air.
[0043] The procedure which carries out optical washing of the optical system (before incorporating optical system in a projection aligner) which included the optical faculty material 2 of the 3rd operation form in the lens-barrel in the state is shown below especially here. First, as shown in drawing 7 , it connected with the gas supply pipe 12 in which gas introduction pipe 7' of the covering 7 of the optical structure was prepared in the source 14 of gas supply, and connected with the gas exhaust pipe 15 in which gas exhaust pipe 7" was prepared by the gas discharge mechanism 16. Opening and closing of the bulb 13 prepared in the gas supply pipe 12 and the gas exhaust pipe 15, respectively and 13' perform introduction of gas, and control of discharge.
[0044] It installed in the optical washing station whose light source is a low-pressure mercury lamp so that light might not be irradiated other than the above-mentioned optical system, and optical washing was performed to it using the light (185nm and 254nm) emitted from a low-pressure mercury lamp. At this time, the inside of the lens-barrel of optical system is filled with air. Since it not only prevents that ultraviolet rays are irradiated by the direct binder, but ozone and active oxygen occur in the case of optical washing and the ozone and active oxygen have bad influence on a binder as Object of the Invention indicated Since it is necessary to prevent that the gas disperses even if it is necessary to protect a binder from ozone or active oxygen and, ultraviolet rays are irradiated by the binder and out gas occurs Opening a bulb 13 to seal space 7a of covering 7, and introducing N2 gas into it by the pressure somewhat higher than the pressure in a lens-barrel (air) from the source 14 of gas supply Bulb 13' is opened and it discharges according to the gas discharge mechanism 16, and the flow of N2 was made in seal space 7a, and neither ozone nor active oxygen enters into seal space 7a of covering 7, but discharged out gas using the flow of N2.
[0045] operation gestalt [of ** a 1st] - the optical system which included the optical structure of the 3rd operation gestalt in the lens-barrel Degradation of the silicon system binder which has been a problem by the conventional optical structure even if it performs the above-mentioned optical washing, And the decline in the permeability which the affix to the optical faculty material top by the out gas from a silicon system binder becomes a cause, and produces did not take place, and the fall of laser endurance did not occur, but the good support state of optical faculty material and the optical property were able to be maintained.
[0046] Drawing 5 is drawing having shown the basic structure of the projection aligner concerning this invention. As shown in drawing 5 , the projection aligner concerning this invention has the light sources 100, such as an excimer laser for supplying

exposure light to the wafer stage 23 in which the substrate W (wafer) which applied sensitization material is laid at least, the lighting optical system 21 which irradiates exposure light at a mask (reticle R), and the lighting optical system 21, and the projection optical system 25 arranged between Wafer W and Reticle R. It is arranged so that the front face (pattern formation side) of Reticle R may come to the body side (P1) of a projection optical system 25, and it is arranged at the image surface (P2) of a projection optical system 25 so that the front face of Wafer W may come.

[0047] Moreover, Reticle R is arranged on a reticle stage 22, and has become the wafer W laid on the wafer stage 23 through the projection optical system 25 in the pattern on Reticle R with the composition which carries out projection exposure. The reticle R exchange system 200 has the function to convey Reticle R between a reticle stage 22 and a reticle cassette while performing the insertion and detachment and exchange of Reticle R which were set to the reticle stage 22.

[0048] Furthermore, it has composition which N2 is supplied through a supply pipe 10 in a projection optical system from N2 source of supply 11 prepared in the projection aligner as shown in drawing 6 , and is supplied to each of the space which was inserted into two lens elements with which N2 goes to the whole, and crosses namely, adjoins it mutually through the supporter material 3 and the breakthrough prepared in each of 3', and by which abbreviation seal was carried out.

[0049] In addition, although not illustrated, the lighting optical system 21 arranged between the light source 100 and Reticle R is contained to one or two or more lens-barrels 8, and it is constituted so that N2 may be supplied in a lens-barrel 8 with the same composition as drawing 6 . The optical system shown in drawing 4 incorporating the optical structure of the 1st operation form and/or the 2nd operation form The place used as a projection optical system 25 of the projection aligner whose light source as shown in drawing 5 is an ArF excimer laser (wavelength of lambda= 193nm) (in a lens-barrel 8) N2 is good for the whole through the breakthrough which N2 was introduced through the supply pipe 10 from N2 source of supply 11 prepared in the projection aligner as shown in drawing 6 , and was prepared in the lens supporter material 3 and 3' -- it is crossing The good result was obtained similarly.

[0050] Thus, the optical system which included the optical structure manufactured with the 1st operation form and the 2nd operation form in the lens-barrel can carry out optical washing, just before including in a projection aligner finally, and after it builds optical system into a projection aligner, it can carry out optical washing. Therefore, even if it irradiates ultraviolet rays when an optical member is included in a projection aligner since the permeability of original of optical faculty material is maintainable, permeability does not fall.

[0051] Moreover, the optical system shown in drawing 4 incorporating the optical structure of the 3rd operation form was used as a projection optical system 25 of the projection aligner whose light source as shown in drawing 5 is an ArF excimer laser (wavelength of lambda= 193nm). As shown in drawing 7 , the gas supply pipe 12 with a bulb 13 and the source 14 of gas supply which supply gas to seal space 7a of the covering 7 of the optical structure in optical system 25, and the gas exhaust pipe 15 with bulb 13' and the gas discharge mechanism 16 are prepared in the projection aligner.

[0052] Since N2 is going and crossing in the lens-barrel 8 of a projection optical system at the whole through the breakthrough which N2 was introduced through the supply pipe 10 from N2 source of supply 11 prepared in the projection aligner, and was prepared in each of lens supporter material 3' as shown in drawing 6 , irradiation of ArF laser is performed in N2 atmosphere, and absorption (attenuation) of ArF laser is suppressed to the minimum. therefore, in carrying out optical (ArF laser) washing in this state Opening a bulb 13 and introducing into seal space 7a of covering 7 N2 gas of a pressure higher than the pressure of N2 introduced in the lens-barrel 8 from the source 14 of gas supply Open bulb 13', discharge according to the gas eccrisis mechanism 16, and the flow of N2 is made in seal space 7a. The ozone generated within a lens-barrel 8 in the case of optical washing, the ozone which enters in seal space 7a among active oxygen, It prevents that open bulb 13', carry out the forced discharge of the ozone and active oxygen which enter in seal space 7a which discharged or mentioned active oxygen above according to the gas eccrisis mechanism 16, and ozone and active oxygen react with a binder.

[0053] Optical washing by the ArF excimer laser of the above-mentioned optical system was performed. The good result was obtained like the above. The low-pressure mercury lamp for optical washing other than an ArF excimer laser in which an ArF excimer laser and a change are possible may be prepared, and optical washing may be performed. Thus, the optical system which included the optical structure manufactured with the 3rd operation gestalt in the lens-barrel 8 can carry out optical washing, just before including in a projection aligner finally, and after it incorporates optical system in a projection aligner, it can carry out optical washing.

[0054] However, in the case of the latter, it is desirable to prepare the gas supply pipe 12 with a bulb 13 and the source 14 of gas supply which supply gas to seal space 7a of the covering 7 of the optical structure, and the gas exhaust pipe 15 with bulb 13' and the gas eccrisis mechanism 16 in a projection aligner. moreover, the optical member arranged between the optical element in lighting optical system, and a photodetector when branching in a part of exposure light by the optical element arranged in lighting optical system and receiving light with a photodetector and/or the binder which fixes a photodetector to supporter material, or a filler -- protection of this invention -- you may prepare a member or a covered member Also in this case, exposure light is not irradiated by a binder or the filler and generating of the out gas from a binder or a filler can be prevented. Therefore, foreign matters, such as the organic substance which originates in a binder or a filler and is produced, can adhere to an optical member or a photodetector (light-receiving side), or it cannot advance into an optical path (suspension) and the light-receiving quantity of light (intensity) can always be detected with a sufficient precision.

[0055] Furthermore, in lighting optical system, this invention is applicable to optical members other than a lens element or a mirror, for example, an interference filter etc. Therefore, even if it irradiates ultraviolet rays when an optical member is included in a projection aligner since the permeability of original of optical faculty material is maintainable, permeability or a reflection

factor does not fall.
[0056]
[Effect of the Invention] As mentioned above, as explained, even if ultraviolet rays are used for the optical system incorporating the optical structure and it concerning this invention within the optical system of the projection aligner made into exposure light, it maintains optical-character ability and degradation of optical faculty material does not produce it. moreover, the optics in the state (optical system) where the optical member in the state where the optical structure concerning this invention was included in supporter material, and the optical structure were included in the lens-barrel -- the optics in the state where a member and optical system were incorporated in the projection aligner -- optical washing of a member is possible
[0057] Therefore, even if it irradiates ultraviolet rays when an optical member is included in a projection aligner since the permeability of original of optical faculty material is maintainable, permeability does not fall.

[Translation done.]